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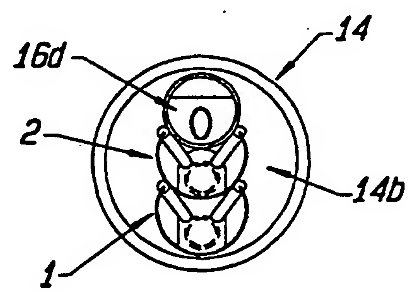
(54) Title: RESECTOSCOPE ELECTRODE ASSEMBLY WITH SIMULTANEOUS CUTTING AND COAGULATION

(57) Abstract

An electrode assembly for a resectoscope includes a cutting electrode (2) with a loop distal tip and a first power density. A coagulation electrode (1) has a loop distal tip and a second power density that is smaller than the first power density. A support frame (6) is connected to the cutting and coagulation electrodes (2, 1). The coagulation electrode (1) provides tissue coagulation simultaneously while the cutting electrode (2) cuts tissue. A resectoscope is disclosed which includes the electrode assembly. The resectoscope includes a sheath (14) with a sheath lumen, a working element (15), and a visualization element (6).

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# RESECTOSCOPE ELECTRODE ASSEMBLY WITH SIMULTANEOUS CUTTING AND COAGULATION

## BACKGROUND OF THE INVENTION

### Field of the Invention

This invention relates generally to resectoscope electrodes, and more particularly, to a resectoscope electrode assembly that simultaneously cuts and coagulates and uses only one power source.

### Description of Related Art

BPH is a benign overgrowth of the prostate gland that is situated at the bladder outlet. BPH is one of the most common conditions affecting men over the age of 50. The incidence increases with age and reaches 80 to 90% at 80 years. In the majority of patients, the BPH causes no symptoms. However, in a certain percentage of patients, the BPH will slowly and progressively obstruct the urinary outflow causing voiding symptoms of bladder obstruction and irritation. Furthermore and yet in a smaller percentage, these symptoms progress to cause complete urinary retention, urinary infections, bladder stones, and kidney damage. The decision to treat or not to treat patients is governed by the presence and absence of symptoms and their severity. Therefore, in the far majority of BPH patients (approximately 70%) who remain asymptomatic, no treatment is needed. In the symptomatic BPH patients, a wide variety of treatment strategies are available.

There are two groups of surgical therapies for BPH based according to the anesthesia requirement. The first group requires general or spinal anesthesia and includes open prostatectomy, transurethral resection of the prostate (TURP), transurethral incision of the prostate (TUIP), transurethral vaporization of the prostate (TVP), visual laser assisted prostatectomy (V-LAP), contact laser prostatectomy, prostate balloon dilation, and intra-prostatic stents. TURP is the

"gold standard" treatment. It has been the most efficacious and durable of all the surgical treatments, with a success rate of 80 - 90%.

The prostate is a highly vascular organ which bleeds during resection (TURP). Bleeding causes a decrease in visual clarity which in turn leads to a variety of intraoperative difficulties with undesirable consequences. The bleeding is the main offending factor responsible for the majority of the problems. Figure 1 is a flow chart listing the complications of the standard TURP.

A typical resectoscope for transurethral resection consists of four main elements. The first element is a rigid telescope for observing the interior of the urinary tract where the surgical procedure is performed. The telescope comprises an objective lens and a series of relay lenses housed within an endoscope barrel or stem, the stem being connected to an eyepiece housing containing suitable lenses for proper magnification. The second element takes the form of a handle assembly commonly referred to as a working element. The working element can serve as the means for connecting electrosurgical current from an electrosurgical generator to the third element, an electrode assembly. The working element is also capable of sliding the electrode assembly along the longitudinal axis of the resectoscope. The combination of the telescope, working element, and electrode assembly is locked into a fourth element, a resectoscope sheath. The sheath consists of a tube and a union body and lock assembly. In the operative procedure the entire resectoscope is placed into the urethra.

The usual resectoscope electrode assembly is in the form of a U-shaped tungsten wire loop, the ends go to one or more wires that fit in a socket in a working element of the resectoscope for current conduction. The wire arms usually merge at their proximal ends and are jointed to an electrode lead extending back to the working element of the instrument. To brace the cutting loop so that it remains uniformly spaced from the telescope stem, a metal spacing sleeve is commonly provided between the telescope stem and either parallel

electrode arms or the distal portion of the electrode lead immediately adjacent to those arms. The metal spacing sleeve is slidable along the telescope stem as the electrode assembly is advanced and retracted and, because of the direct contact between the spacing sleeve and the telescope stem, it has been necessary in the part to insure adequate insulation between the electrode and the sleeve.

To date, all new and alternative surgical therapies have generally failed to exhibit similar efficacy and durability, however, they have shown certain advantages in minimizing morbidity, the amount of blood loss that is experienced and are easier to perform. There is a need for a safer and less morbid approach than TURP that exhibits similar durable efficacy.

The second group of surgical therapies require local anesthesia without the need for general or spinal anesthesia. These treatments utilize different energies to deliver thermal therapy to the prostate. They include transurethral microwave thermotherapy (TUMT), transurethral thermal-ablation therapy (T3), high intensity focused ultrasound (HIFU), laser delivered interstitial thermal therapy (LDIT), and transurethral needle ablation of the prostate (TUNA). These treatments are less morbid that conventional TURP. Such thermal therapies are currently under investigation and will require completion of phase three trials and FDA approval before they make their debut into the market.

There is a need for a bloodless TURP apparatus, as shown in Figure 1, thus alleviating virtually all of the problems of the standard TURP devices. This can be achieved in a TURP apparatus which provides simultaneous cutting and coagulation.

## SUMMARY OF THE INVENTION

Accordingly, it is an object of the invention is to provide an electrode assembly for a resectoscope that includes a coagulation electrode loop that operates simultaneously (within approximately one second) with a cutting electrode loop.

Another object of the invention is to provide an electrode assembly for a resectoscope that includes a coagulation electrode, a cutting electrode, and a single power source that supplies power to both electrodes.

Still another object of the invention is to provide an electrode assembly for a resectoscope that includes a coagulation and cutting electrode with a single loop with different current densities that simultaneously cuts and coagulates and includes a single power source.

Another object of the invention is to provide an electrode assembly for a resectoscope that includes a coagulation electrode and a cutting electrode, each with a distal end loop configuration, and each with different current densities.

Yet another object of the invention is to provide an electrode assembly for a resectoscope which includes a cutting and coagulation loop with first and second current densities, and wherein the loop provides simultaneous cutting and coagulation.

Still another object of the invention is to provide an electrode assembly for a resectoscope which includes a coagulation loop and a cutting loop, and the coagulation loop has insulation on a contact surface in order to provide a coagulation loop current density that is lower than a cutting loop current density

A further object of the invention is to provide an electrode assembly for a resectoscope which includes a coagulation loop and a cutting loop, and the coagulation loop has an increased surface area in order to provide a coagulation loop current density that is lower than a cutting loop current density.

Another object of the invention is to provide an electrode assembly for a resectoscope which includes a coagulation loop and a cutting loop, and the coagulation loop includes a coil, resistive element or a printed circuit on a contact surface in order to provide a coagulation loop current density that is lower than a cutting loop current density.

Another object of the invention is to provide an electrode system to improve TURP procedures that is substantially bloodless.

A further object of the invention is to provide an electrode system to improve TURP procedures that provides increased visual clarity.

These and other objects of the invention are provided in an electrode assembly for a resectoscope. The electrode assembly for a resectoscope includes, a cutting electrode and a coagulation electrode, both with distal tip loops. The cutting electrode loop has a higher current density than the current density of the coagulation loop. This permits the use of a single energy source, and eliminates the need for a converter box. A support frame connects the cutting and coagulation electrodes to the energy source which supplies energy from the power source to the electrodes. A variety of energy sources can be utilized including but not limited to RF, microwave, thermal, and the like. The coagulation electrode provides tissue coagulation simultaneously while the cutting electrode cuts tissue.

In another embodiment of the invention, the electrode assembly has only one loop, which simultaneously cuts and coagulates. The loop has a coagulation portion with a lower power density than a cutting portion. This is achieved by a variety of methods, including but not limited to using different (i) materials, (ii) geometries, (iii) dimensions, or (iv) insulations.

In yet another embodiment of the invention, a resectoscope is disclosed which includes the electrode assembly. The resectoscope includes a sheath with a sheath lumen, a working element, and a visualization apparatus.

The resectoscope includes a sheath including a sheath lumen, a distal end and a proximal end. An electrode assembly includes, a cutting electrode with a distal end with a loop geometry, a coagulation electrode with a distal end, with the coagulation electrode distal tip coagulating tissue simultaneously when the cutting electrode cuts tissue. A working element attaches to the proximal end of the sheath.

Further, a visualization apparatus is provided and housed through a working element in a sheath lumen extending from the sheath distal end to a proximal end of the handle of the working element.

The present invention provides an intra-operative electrode assembly for a resectoscope, and a resectoscope that provides: simultaneous cutting and coagulation under direct visualization; a performance that is easier for the urologist; a lower risk of entering venous sinus; a lower risk of further bleeding; decreased potential for blood transfusions; less fluid irrigation and bladder distention; less risk of TURP syndrome; lower risk of capsular penetration and subsequently less risk of fluid extravasation into the abdomen; lower risk of urinary sphincter injury and subsequently less risk of urinary incontinence; lower risk of ureteral orifice injury and subsequently less risk of ureteral obstruction and vesicoureteral reflux; shorter operative time; less need for bladder catheterization and Foley traction postoperatively; lower risk of postoperative scarring and bladder neck contracture; less need for postoperative bladder irrigation; a shorter duration for postoperative Foley catheterization; a shorter hospital stay; and an associated cost less than the standard TURP.

Only one energy source is required. The electrode assembly can include one or more electrode loops. One loop can cut while a second loop simultaneously coagulates. Alternatively, a single loop can provide both functions simultaneously. In any event, only one energy source is required because there are different current densities for cutting and coagulation. The electrode system of the present invention, as well as the resectoscope, can be used with substantially all RF commercial power sources.

Another object of the invention is to provide an electrical conduit unit in the form of a cable with a transformer unit incorporated within. The transformer splits the energy generated by the energy supply source into two given energy power levels while the cable transfers the energies to the electrode assembly of the resectoscope. This transformer

unit can also be made without incorporating it into the cable as a separate transformer (converter). The function of both the transformer unit and the converter is to split the energy into two given energy power levels that can be altered and adjusted for suitable dual simultaneous cutting and coagulation function of the electrode assembly.

## BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a flow diagram illustrating the complications of the standard TURP procedure.

Figure 2(a) is a perspective view of one embodiment of the electrode assembly of the present invention.

Figure 2(b) is an end-view of the electrode assembly 2(a) along lines 2(b) - 2(b).

Figure 2(c) is a cross-sectional view of the electrode assembly 2(a) taken along the lines 2(c) - 2(c).

Figure 2(d) is a cross-sectional view of one embodiment of the electrode assembly 2(a) taken along view lines 2 - 2 , with the cutting and coagulation electrode distal tips having different current densities by reducing the contact surface between the electrode and tissue at a given power level.

Figure 2(e) is a cross-sectional view of one embodiment of the electrode assembly 2(a) taken along view lines 2 - 2, with the cutting and coagulation electrode distal tips having different current densities by reducing the contact surface between the electrode and tissue at a given power level.

Figure 2(f) is a cross-sectional view of one embodiment of the electrode assembly 2(a) taken along view lines 2 - 2, with the cutting and coagulation electrode distal tips having different current densities by reducing the contact surface between the electrode and tissue at a given power level.

Figure 2(g) is a cross-sectional view of one embodiment of the electrode assembly 2(a) taken along view lines 2 - 2, with the cutting and coagulation electrode distal tips having different current densities, by changing the

material of the electrode to limit the current flow through the electrode.

Figure 2(h) is a cross-sectional view of a single cutting and coagulation distal tip that cuts and coagulates simultaneously, and has different current densities for the cutting and coagulation sections of the single distal tip by having a segmented electrode composed of multiple layers of alternating metal and insulation.

Figure 3(a) is perspective view of a second embodiment of electrode assembly of the present invention.

Figure 3(b) is an end-view of the electrode assembly 3(a) along lines 3(b) - 3(b).

Figure 3(c) is a cross-sectional view of the electrode assembly 3(a) taken along the lines 3(c) - 3(c).

Figure 3(d) is a cross-sectional view of the electrode assembly 3(a) taken along the lines 3(d) - 3(d).

Figure 3(e) is a cross-sectional view of the electrode assembly 3(a) taken along the lines 3(e) - 3(e).

Figure 4(a) is a perspective view of the resectoscope

Figure 4(b) is an end-view of the of the resectoscope 4(a) along lines 4(b) - 4 (b).

Figure 5(a) is a diagram of the resectoscope, power supply, and the converter of the present invention.

Figure 5(b) is a diagram of the resectoscope, power supply, and the present invention of transformer conduit unit (without the converter).

Figure 6 is a schematic diagram of the electronics for a converter (23) of the present invention of figure 5(a)

Figure 7 is a schematic diagram of electronics of one embodiment of the transformer (20) of figure 5(a) being a mono-polar device coupled to a bipolar outlet of an RF power source.

Figure 8 is a schematic diagram of electronics of a second embodiment of the transformer (20) of figure 5(a) being a mono-polar device coupled to a bipolar outlet of an RF power source.

Figure 9(a), 9(b), 9(c), and 9(d) are schematic diagrams of electronics of third, forth, fifth, and sixth

embodiments of the transformer (20) of figure 5(a) being a bi-polar device coupled to a bipolar outlet of an RF power source.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention is an electrode assembly for a resectoscope and includes, a cutting electrode and a coagulation electrode, both with distal tip loops. The functional aim of the electrode assembly is to achieve simultaneous tissue cutting and coagulation during surgery. The electrode assembly receives its energy from an power supply source energy. The conventional primary energy generated by the power supply source is converted and split into two separate energies, one for each of the distal loops of the electrode assembly. A purposely designed energy converter or transformer conduit unit is responsible for this. This permits the use of a single energy source to supply two given energy powers to the two electrode assembly loops to allow them to have different functional properties operating simultaneously, one for tissue cutting and another for tissue coagulation. Furthermore, a variety of electrode assembly distal tips (loops) designs are presented which are based on but not limited to (i) materials, (ii) geometries, (iii) dimensions, or (iv) insulations to allow additionally functional adjustments and alterations. A variety of energy sources can be utilized including but not limited to RF, microwave, thermal, and the like.

In another embodiment of the invention, the electrode assembly has only one loop, which simultaneously cuts and coagulates. The loop has a coagulation portion with a lower power density than a cutting portion. This is achieved by a variety of methods, including but not limited to using different (i) materials, (ii) geometries, (iii) dimensions, or (iv) insulation.

In yet another embodiment of the invention, a resectoscope is disclosed which includes the electrode assembly, a resectoscope sheath, a working element, and a visualization apparatus.

Further, as compared to devices currently used for standard TURP's, the present invention has: increased visual clarity; a performance that is easier for the urologist; a lower risk of entering venous sinus; a lower risk of further bleeding; decreased potential for blood transfusions; less fluid irrigation and bladder distention; less risk of TURP syndrome; lower risk of capsular penetration and subsequently less risk of fluid extravasation into the abdomen; lower risk of urinary sphincter injury and subsequently less risk of urinary incontinence; lower risk of ureteral orifice injury and subsequently less risk of ureteral obstruction and vesicoureteral reflux; shorter operative time; less need for bladder catheterization and Foley traction postoperatively; lower risk of postoperative scarring and bladder neck contracture; less need for postoperative bladder irrigation; a shorter duration for postoperative Foley catheterization. a shorter hospital stay; and an associated cost less than the standard TURP.

For purposes of this disclosure, the word "simultaneous" means, (i) RF energy is supplied at the same time to the cutting and coagulation electrode distal tips, (ii) RF energy is supplied to both distal tips in less than 1 second, (iii) within the same hand action, e.g., on a forward stroke or on a back stroke, energy is only supplied in the cutting mode, and on the other stroke it is only supplied in the coagulation mode, (iv) when energy is delivered to the distal tips the coagulation tip has a thermal or RF spread of energy that reaches the cutting distal tip when it is cutting, (v) two currents go out to both distal tips at the same time and (vi) the transfer of thermal energy from the coagulation electrode to the site of the cutting electrode occurs in less than one (1) millisecond. It will be appreciated that thermal spread from the coagulation tip is controllable. The higher the energy, the greater the spread. The lower the energy, the lower the spread. It is possible to have the RF energy spread extend beyond the cutting electrode's physical location.

The electrode system and resectoscope of the present invention can be operated in bipolar or monopolar modes.

Bipolar is particularly suitable when the two electrodes are closer together, and in those instances when RF energy spread between the two electrodes is desired to be limited or controlled. The shorter the distance between the two electrodes, then RF energy spread does not appreciably extend beyond the electrodes. This is particularly useful in those instances where that RF energy spread to surrounding or adjacent tissues or structures this can lead to an undesirable result.

Further, the present invention can be employed in gastrointestinal endoscopic surgery, general laparoscopic surgery, thoracoscopy, heat and neck surgery, orthopedics, gynecology and the like. A gastrointestinal resectoscope can be used to resect intestinal tumors and other lesions endoscopically. The electrode system and resectoscope of the present invention provides safer resection of these tumors and lesions with improved visualization and reduced morbidity and mortality. Laparoscopic excisional biopsies, resection, dissection of lesions and surgical planes involving internal organs, such as the liver and the like, can be achieved more readily with fewer complications. Head and neck applications include but are not limited to the oral cavity, throat, larynx, pharynx, sinuses, ears and pulmonary system. Biopsies and excisions of lesions with bleeding potentials including but not limited to hemangiomas, nasal polyps, cancers and the like, can be performed using the present invention. Endoscopic orthopedic surgery applications include but are not limited to resections of prolapsed and ruptured vertebral discs, torn joint cartilage, scars, spurs and the like. Gynecological surgery includes excision for endometriosis lesions, tumors, lymph nodes, and the like.

Referring now to figures 2(a), 2(b), and 2(c) which illustrate the electrode assembly. The electrode assembly in its distal tip, comprises two electrode loops, a cutting loop 1 and a coagulation loop 2. Suitable electrode loop geometry include but not limited to, radial, circular, elliptical, curved, rounded, bowed, arc, arch, crescent, semicircular, malleable and roller (whirler, revolver, rotary) cylinder, and

can also include a roller ball. In one embodiment, a plurality of roller balls are included to form a loop with any of the previously mentioned geometries. The loop size diameter can be 3 mm (9 French gauge) to 10 mm (30 French gauge), or any size that will fit in a commercially available resectoscope (8-28 French gauge). Cross-section shapes of the wires include, circular, hemicircular, any portion of a circle, square, triangular, shapes such as hexagon, octagon,etc. flat plate, and combination of the above. The wire can include horizontal or longitudinal grooves. The cross-sectional diameter of the wire can be from about 0.25 to 4 mm. The size of the roller can be 0.25 to 4 mm. The cutting loop 1 and the coagulation loop 2 can be in a fixed distance relationship to each other. The distance between the two loops can range between 1 to 6 mm. This permits sufficient time for the cutting loop 1 to cut tissue, while simultaneously coagulation loop 2 is coagulating tissue at a slight distance away. The proper separation distance permits the two loops from effectively cutting and coagulating simultaneously without interfering with each other.

Cutting loop 1 is continuous with wire limbs 1a & 1b. Coagulation loop 2 is continuous with wire limbs 2a & 2b. Wires 1a and 2a terminate in end caps 7 and 8 respectively which serve in connecting them to the energy supply source. Wires 1b and 2b terminate blindly along the electrode assembly body where they are individually insulated from the rest of the electrode assembly components. Through end cap 7, the energy is transmitted to wire 1a to reach cutting loop 1. Through end cap 8, the energy is transmitted to wire 2a to reach coagulation loop 2. Electrode wires 1b and 2a are individually packaged inside steel tubing 3 and outside insulation sleeve 4, all of which are encased within housing sleeve 5. Electrode wires 1a and 2b are similarly packaged inside steel tubing 3 and outside insulation 4 and encased within housing sleeve 5. The thickness of the insulation sleeve is in the range of 0.001 to 0.100 inches. The housing sleeves 5 extend along the electrode assembly to variable distances to permit sufficient support and rigidity to its inside contents.

Optical guide sleeve(s) 6 is part of the electrode assembly that is a guide tube for optics, including but not limited to relay lenses and the like, and provides a supporting frame for electrode loops 1 and 2, electrode wires 1a, 2a, 1b, 2b, steel tubing 3, and housing sleeves 5. Optical guide sleeve 6 can be cylindrical, tubular, or a portion of a cylinder or tube. Further, optical guide sleeve 6 can be singular or multiple in number. It can range from 0.1 mm to 30 cm, i.e., it can extend from the proximal to the distal ends of electrode assembly. Optical guide sleeves 6 are mounted to housing sleeves 5 anywhere along the length of the electrode assembly depending on the design of the resectoscope.

Cutting loop 1 and coagulation loop 2 can be made of a variety of electrical conductive materials including but not limited to tungsten, its alloys, stainless steel and the like. A preferred material is a tungsten wire. Their corresponding electrode wires 1a, 2b, 1b, and 2b can be similarly made of variety of electrical conductive materials. Insulating sleeves 4 can be made of a dielectric material including but not limited to, (i) fluropolymers, (ii) polyimide, (iii) polyamide, (iv) polyaryl sulfone and (v) silicone plastic. Steel tubing 3, housing sleeve 5 and optic guide sleeve 6 can be made of stainless or corrosion resistant material such as stainless steel, and the like.

Referring now to Figures 2(d) through 2(g) the cross sections of cutting loop 1 and coagulation loop 2 are illustrated in a variety of embodiments. In Figures 2(d) through 2(g) two loops of different power levels are created by applying insulation (e.g. Teflon, oxides, paint) selectively. In each embodiment, the current density for coagulation loop 2 is lower than the current density of cutting loop 1. In Figure 2(d) insulation is applied to a contact surface of coagulation loop 2. The electrodes are the same size in Figure 2(d), while the electrodes in Figure 2(e) have different sizes. In Figure 2(e) coagulation loop 2 18 has an increased surface area. In Figure 2(f) coagulation loop 2 has insulation applied substantially around it. In Figure 2(f) there is increased

size and increased path. Referring now to Figure 2(g), area is increased by providing coils.

Referring now to Figure 2(h) cutting and coagulation functions are combined into a single distal loop with a sharp cutting edge that is a hotter point and a larger coagulation surface at the other side.

Refer now to figures 3(a), 3(b), 3(c), 3(d), and 3(e) which illustrate an alternative electrode assembly. In this embodiment, a single arm conductor rod transfers and transmits two electrical currents through rods 1c & 2c to the body via cutting electrode 1 and coagulation electrode 2. Within crimp 9 inside housing 10, rod 1c connects to electrode wire 1a which extends distally to form cutting loop 1 and returns back as electrode wire 1b. In a similar fashion within crimp 9 inside housing 10, rod 2c connects to electrode wire 2a which extends distally to form cutting loop 2 and returns back as electrode wire 2b. Both electrode wires 1b & 2b return back into crimp 9 where they end blindly inside and get insulated from the rest of the electrode assembly components. On there way distally to form the cutting loop 1 and the coagulation loop 2, each electrode wire lies inside individual steel tubing 3 and insulation 4.

Proximally, rod 1c resides within hollowed rod 2c with inner insulating sleeve 11 in between. Outer insulation sleeve 12 covers the outside of rod 2c. Housing sleeve 3 surrounds segments of the outer insulation 12 to allow support and to add body stiffness to the electrode assembly. At the proximal end of the electrode assembly, rod 1c and 2c are exposed free of the insulation sleeves 11 & 12 to allow connection to the energy supply source. The purpose of the proximal single arm electrode assembly is to allow its use in a variety of commercially available resectoscopes. Insulating materials can be any of the commonly used plastics or other non-conducting materials accepted for medical devices. Further includes, a lock catch 10 and optic guide sleeve 6.

Referring now to figures 4(a) and 4(b) which illustrate the resectoscope. The resectoscope includes the following parts: a sheath 14, a working element 15, and a

visualization apparatus 16. These parts together with the electrode assembly fits in with each other to form a functional resectoscope. When assembled, the cutting and coagulation loops 1 & 2 of the electrode assembly are positioned within the sheath lumen 14a at the distal end of the resectoscope sheath 14.

The resectoscope sheath 14 has a sheath lumen 14b that extends substantially along the entire length of the sheath from its distal end 14a to its proximal end 14e. Near its proximal end 14e, lie an inflow socket 14c and an outflow socket 14d used to circulate fluid irrigation during surgery.

The resectoscope working element 15 of the resectoscope include the following elements (i) a thumb grip handle 15a, (ii) a finger grip handle 15b, (iii) a spring mechanism 15c located between the two handles this serve in maintaining the handles apart, i.e., the electrode assembly tips inside the sheath; further spring mechanism 15c also serves to restore this position following manual deployment out of the electrode assembly distal loops, (iv) an internal socket 15d where the proximal end of the electrode assembly is plugged into and secured in for electric current connection and transmission, and (v) an external socket 15e for plugging in an external cable that transmits electric currents from the converter and energy supply source. All connections are insulated to prevent dissipation of the electric current. The electrode assembly fits into and through the working element 15.

The resectoscope visualization apparatus 16 includes a proximal end 16a with an eye piece, a socket 16b for attachment of a light source cable, a rod lens 16c and a distal end 16d. The rod lens 16c is the actual body of the visualization apparatus 16 and extends from the proximal end 16a to the distal and 16d.

The optical guide sleeve 6 of the electrode assembly, (i) guides the placement and attachment of the rod lens to the electrode assembly and stabilizes the two together, (ii) maintains and supports the correct and proper position of the electrode assembly through the sheath lumen 14b and (iii)

allows the electrode assembly to longitudinally slide in and out parallel to the lens rod 16c during usage and maintains this positional relationship throughout the surgical procedure.

Referring now to Figure 5(a), resectoscope 18 receives power from energy supply source 24. The energy supply source is activated by foot control 26. The energy generated from energy supply source 24 is transported through electric cable 17 to converter 23 where the energy is split into two given energy power levels. The ratio of energy split and the levels of energy power exiting converter 23 can be adjusted manually on its front panel 23(a) that allow simultaneous cutting and coagulation. The primary mode of current delivery is cut and coagulate but can also include other modes such as (i) cut and cut, (ii) coagulate and coagulate and other combinations as determined by the controls on front panel 23(a). Electric cable 19 transports the split energies into resectoscope 18 to supply two loops (loop 1 & 2) of its electrode assembly for simultaneous cutting and coagulation. By using two different current densities in loops 1 and 2 or in a single loop as in embodiment 2(h), only one energy supply source 24, is necessary. Converter 23 permits substantially any commercially available energy supply sources to be utilized with the present invention. Suitable RF power supplies are commercially available from Valley Labs, Erbe, as well as from other commercial vendors. Other energy sources can also be used including but not limited to microwave, ultrasound, thermal and other electromagnetic sources.

Referring now to Figure 5(b), resectoscope 18 receives power from energy supply source 24 through transformer/conduit unit 20. The energy supply source is activated by foot control 26. The transformer/conduit unit 20 consists of an electrical conduit (cable) 20(b) that plugs to the power supply source 24 through its proximal end adapter 20(c). The distal end of the electrical conduit plugs into resectoscope 18. Along the electrical conduit, and incorporated into it, lies transformer unit 20(a). In figure 5(b), the transformer unit 20(a) is located towards the distal end of the transformer/conduit unit 20 but is not limited to

this location. The transformer unit 20(a) can be located anywhere along the length of the transformer/conduit unit 20. A grounding pad 22(a) is placed on the patient's skin and attached to it is grounding cable 22(b). The grounding cable 22(b) has adapter 22(c)at its proximal end which connects to the energy supply source 24. Adaptor 22(c) also connects to adaptor 20(c) of transformer/conduit unit 20 through connecting cable 21.

As shown in Figure 6 bridge 30 rectifies the RF signal, which is then filtered by filter 31, and regulated by a regulator 32 which provides a supply voltage to the control electronics for two channels. The two control channels are identical. RF from an external generator is delivered symmetrically to first and second FET device pairs 40 and 40', which act as voltage controlled power resistors. A gate voltage is generated by sampling an output from current sensors 41 and 41', and bridge rectifiers 42 and 42', and comparing it to a preset level. The preset level is obtained through six position switches 43 and 43', and resistor networks 44 and 44' connected to Vcc power supply as a divider. Amplifiers 45 and 45' compare the two levels and the difference drives FET pair gates 40 and 40'. Output RF to cutting loop tip 1 and coagulation loop 2 is provided through isolation transformers 46 and 46' that also bias first and second FET pairs 40 and 40'. Capacitors on the output provide DC blocking to further protect the patient.

Referring now to the cable schematics of Figure 7 only one power supply 24 is used without electronic control to maintain the power level. Cut or coagulation electrode has a variable center tap 52, permitting selectivity of splitting with a given amount of power from power supply 24. In Figure 8, the cable permits monopolar remote control. Included is a remote control switch 50. The position of switch 50 is transferred through conductors inside the cable to a relay driver 51 which switches center taps 52 to achieve a desired combination.

Figures 9(a), 9(b), 9(c), and 9(d) illustrate bipolar embodiments. The embodiment illustrated in Figure 9 (a) and

9(d) is not pre-wired, while the cable in Figure 9(b) and 9(c) is pre-wired. Figures 9(a), 9(b), 9(c), and 9(d) illustrate that power is received by a bi-polar outlet even though it operates in a mono-polar mode with a groundpad.

The underlying principle on which the embodiment in figures 7, 8, 9(a), 9(b), 9(c), and 9(d) are based, is the ability to split a given RF power level at a transformer primary into two or more secondary outputs according to the ratio of the individual secondary windings to the windings of the primary. Since the secondary windings deliver the RF power to monopolar electrodes in the resectoscope of this disclosure, a ground return must be provided when the bipolar output of an ESG is used by connecting a ground to the reference tap 21 in figure 5(b)

In operation, power supply 24 is set to a power level greater than the maximum required level by at least 5 watts, in order to power the electronics. Individual power level for each channel is preset by control switches. When power supply 24 delivers power, each channel delivers an attenuated level of power according to the switch setting.

The foregoing description of a preferred embodiment of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in this art. It is intended that the scope of the invention be defined by the following claims and their equivalents.

**WHAT IS CLAIMED IS:**

1. An electrode assembly for a resectoscope, comprising:

a) a cutting electrode with a loop distal tip for providing a first power density;

b) a coagulation electrode with a loop distal tip for providing a second power density that is lower than the first power density; and

c) conductor means connected to the cutting and coagulation electrodes and to an energy source to supply energy from the energy source to the cutting and coagulation electrodes, wherein the coagulation electrode provides tissue coagulation simultaneously while the cutting electrode cuts tissue.

2. The electrode assembly for a resectoscope of claim 1, wherein the cutting electrode loop distal tip has a smaller cutting contact surface area than a coagulation contact surface area of the coagulation loop distal tip.

3. The electrode assembly for a resectoscope of claim 1, wherein the coagulation loop distal tip has insulation on the coagulation contact surface area.

4. The electrode assembly for a resectoscope of claim 1, wherein the coagulation loop distal tip has a resistive material on a surface of the coagulation loop distal tip.

5. The electrode assembly for a resectoscope of claim 1, wherein the coagulation loop distal tip has a geometry that provides the second power density that is lower than the first power density of the cutting loop distal tip.

6. The electrode assembly for a resectoscope of claim 1, wherein the energy source is coupled to the coagulation and cutting loop distal tips, wherein the energy source delivers the same energy to each of the coagulation and cutting loop distal tips.

7. The electrode assembly for a resectoscope of claim 6, wherein the conductor means includes two electrical conductors.

8. The electrode assembly for a resectoscope of claim 7, wherein the conductor means comprises at least two materials which provide different current densities to each of the coagulation electrode loop distal tip and cutting electrode loop distal tip.

9. The electrode assembly for a resectoscope of claim 1 wherein the coagulation electrode provides tissue coagulation within one second after the cutting electrode cuts tissue.

10. A resectoscope, comprising:

a) a sheath including a sheath lumen, a distal end and a proximal end;

b) an electrode assembly including,

- a cutting electrode with a loop distal tip geometry for providing a first power density;

- a coagulation electrode with a loop distal tip for providing a second power density that is lower than the first power density, the coagulation electrode distal tip loop capable of coagulating tissue simultaneously while the cutting electrode distal tip loop cuts tissue;

c) a working element attached to the proximal end of the sheath; and

d) a visualization apparatus housed in a lumen extending from the sheath distal end to a proximal end of the working element.

11. The resectoscope of claim 10, wherein the cutting electrode loop distal tip has a smaller cutting contact surface area than a coagulation control surface area of the coagulation loop distal tip.

12. The resectoscope of claim 11, wherein the coagulation loop distal tip has insulation material on the coagulation contact surface area.

13. The resectoscope of claim 10, wherein the coagulation loop distal tip has resistive material on a surface of the coagulation loop distal tip.

14. The resectoscope of claim 10, wherein the coagulation loop distal tip has a geometry that provides the second power density that is lower than the first power density of the cutting loop distal tip.

15. The resectoscope of claim 13, further comprising:

a power source coupled to the coagulation and cutting loop distal tips, wherein the power source is connected to each of the coagulation and cutting loop distal tips.

16. The resectoscope of claim 15, further comprising:

an energy delivery apparatus coupled to the power source and to the coagulation and cutting loop distal tips.

17. The resectoscope of claim 16, wherein the energy delivery apparatus includes at least one electrical conductor.

18. The resectoscope of claim 17, wherein the energy delivery apparatus is made of at least two materials which provide different current densities to each of the coagulation and cutting loop distal tips.

19. The resectoscope of claim 16, wherein the energy delivery apparatus includes two electrical conductors.

20. The resectoscope of claim 19, wherein the two electrical conductors are made of different materials.

21. The resectoscope of claim 19 wherein said energy delivery apparatus further includes means for transforming power from the external power supply for application to said cutting loop and to said coagulation loop.

22. The resectoscope as defined by claim 21 wherein said means for transforming includes a monopolar adjustable transformer for varying the ratio of power delivered to said cutting loop and to said coagulation loop.

23. The resectoscope as defined by claim 21 wherein said means for transforming includes a bipolar primary winding.

24. The resectoscope of claim 10, wherein the cutting electrode distal end and the coagulation electrode distal end are in a fixed relationship to each other.

25. The resectoscope of claim 10, wherein the visualization apparatus is a telescope assembly with optics.

26. The resectoscope of claim 25, wherein the telescope assembly includes a fiber optic.

27. The resectoscope of claim 10, wherein a proximal end of the visualization apparatus includes a magnification eyepiece.

28. An electrode assembly for a resectoscope, comprising:

a) a unitary cutting and coagulation electrode with a loop distal tip, a cutting section and a coagulation section, wherein the cutting section provides a first current density

and the coagulation section provides a second current density that is lower than the first current density; and

b) conductor means connected to the cutting and coagulation electrode and to an energy source to supply energy from the energy source to the cutting and coagulation electrode, wherein the cutting and coagulation electrode provides simultaneously cutting and coagulation.

29. The electrode assembly for a resectoscope of claim 28, wherein the cutting section has a smaller cutting surface area than a coagulation surface area of the coagulation section.

30. The electrode assembly for a resectoscope of claim 29, wherein the coagulation section has a geometry that provides a power density lower than a power density of the cutting section.

31. A resectoscope comprising:

a sheath,

a telescope within said sheath having an eyepiece at a proximal end of said resectoscope,

an electrode assembly within said sheath including a cutting loop and a coagulation loop at a distal end of said resectoscope for simultaneously cutting tissue and coagulating tissue, said cutting loop capable of providing a power density greater than a power density of said coagulation loop,

conductor means extending through said sheath for interconnecting said electrode assembly to an external power supply, and

a handle assembly at said proximal end of said resectoscope coupled to said electrode assembly for moving said electrode assembly in said sheath.

32. The resectoscope as defined by claim 31 wherein said conductor means includes means for transforming power from the external power supply for application to said cutting loop and to said coagulation loop.

33. The resectoscope as defined by claim 32 wherein said means for transforming includes a monopolar adjustable transformer for varying the ratio of power delivered to said cutting loop and to said coagulation loop.

34. The resectoscope as defined by claim 32 wherein said means for transforming includes a bipolar primary winding.

35. A method of simultaneously cutting and coagulating tissue comprising the steps of

a) providing an electrode assembly including a cutting loop and a coagulation loop,

b) energizing said electrode assembly whereby said cutting loop has a first power density and said coagulation loop has a second power density lower than said first power density, and

c) moving said cutting loop and said coagulation loop through tissue whereby said tissue is simultaneously cut by said cutting loop and coagulated by said coagulation loop.

36. The method as defined by claim 35 and further including the step of applying a fluid irrigation to said tissue during step c).

37. The method as defined by claim 35 wherein a power source is applied directly to said cutting electrode and to said coagulation electrode, the first power density and the second power density being determined by electrode configuration.

38. The method as defined by claim 35 wherein a power source is coupled through transformer means to said cutting electrode and to said coagulation electrode.

39. The method as defined by claim 35 wherein tissue is cut by said cutting loop within approximately one second of tissue coagulation by said coagulation loop.

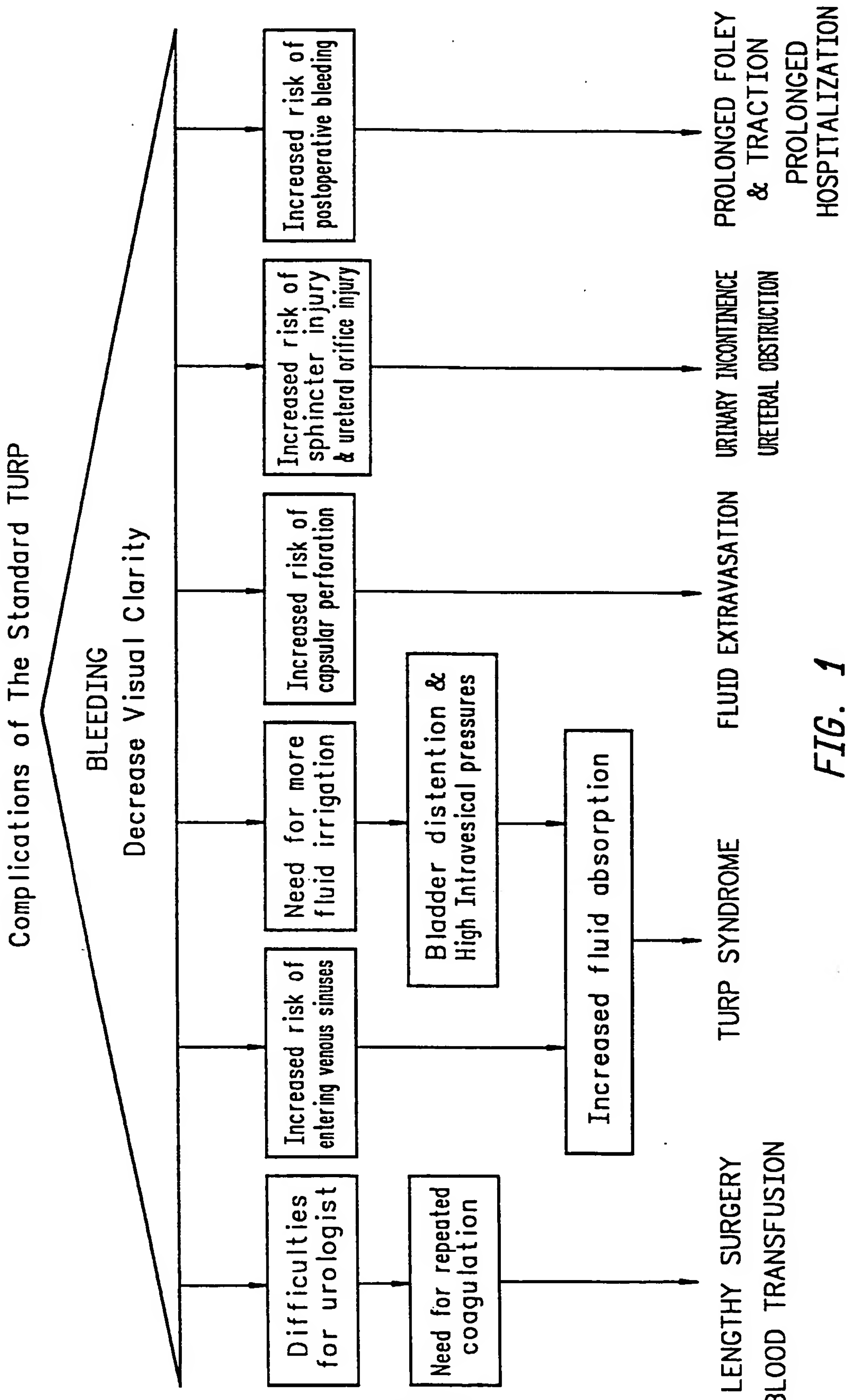
Complications of The Standard TURP
BLEEDING
Decrease Visual Clarity
Difficulties for urologist
Need for repeated coagulation
Increased risk of entering venous sinuses
Need for more fluid irrigation
Bladder distention & High Intravesical pressures
Increased fluid absorption
Increased risk of capsular perforation
Increased risk of sphincter injury & ureteral orifice injury
Increased risk of postoperative bleeding
LENGTHY SURGERY
BLOOD TRANSFUSION
TURP SYNDROME
FLUID EXTRAVASATION
URINARY INCONTINENCE
URETERAL OBSTRUCTION
PROLONGED FOLEY & TRACTION
PROLONGED HOSPITALIZATION

FIG. 1

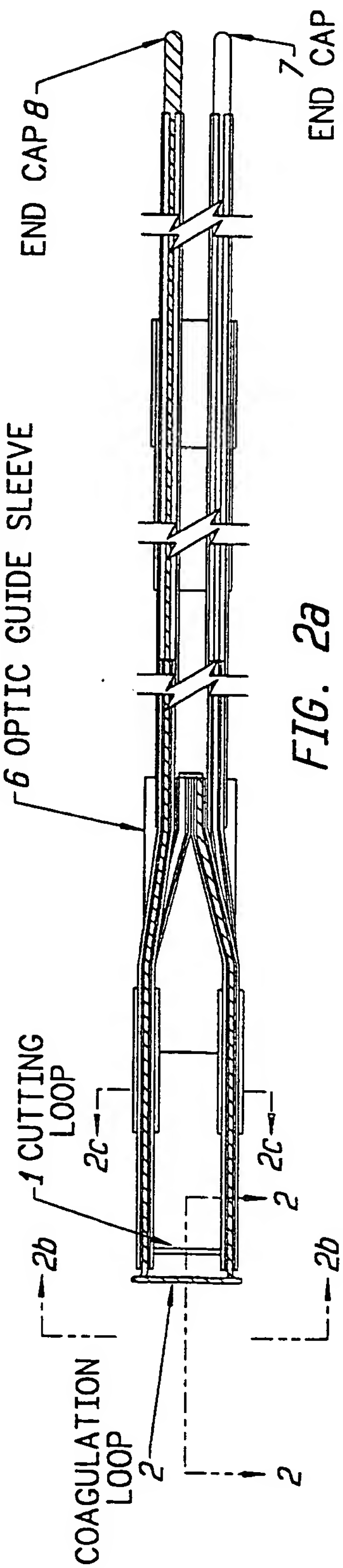


FIG. 2a

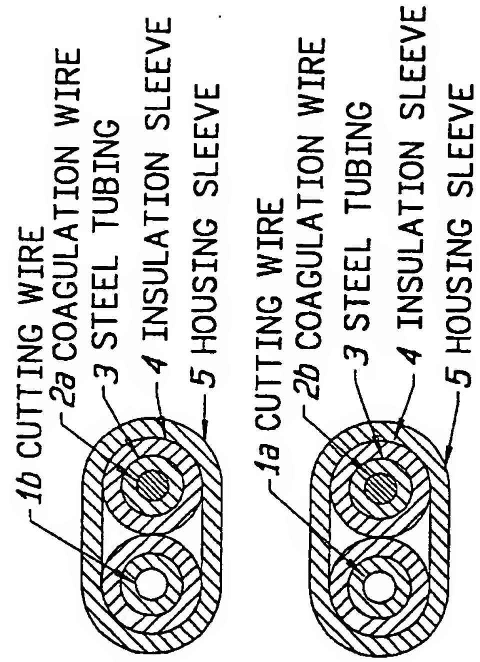


FIG. 2c

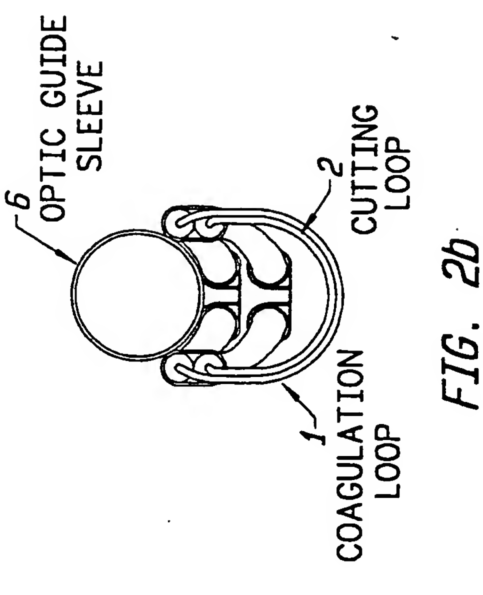


FIG. 2b

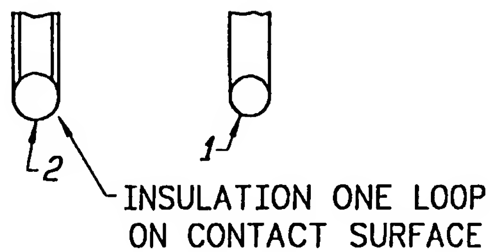


FIG. 2d

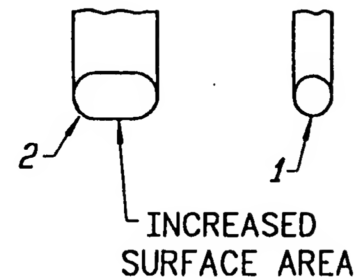


FIG. 2e

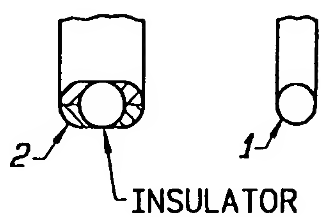


FIG. 2f

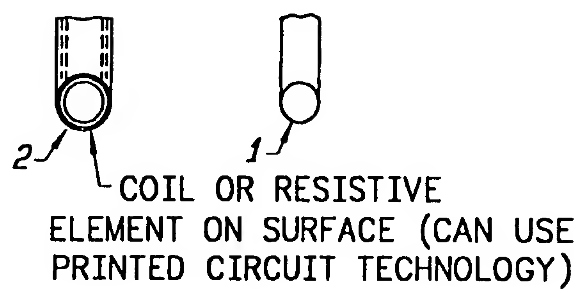


FIG. 2g

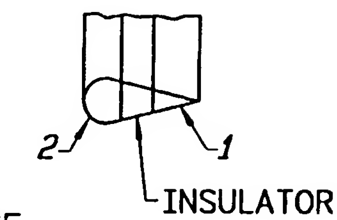


FIG. 2h

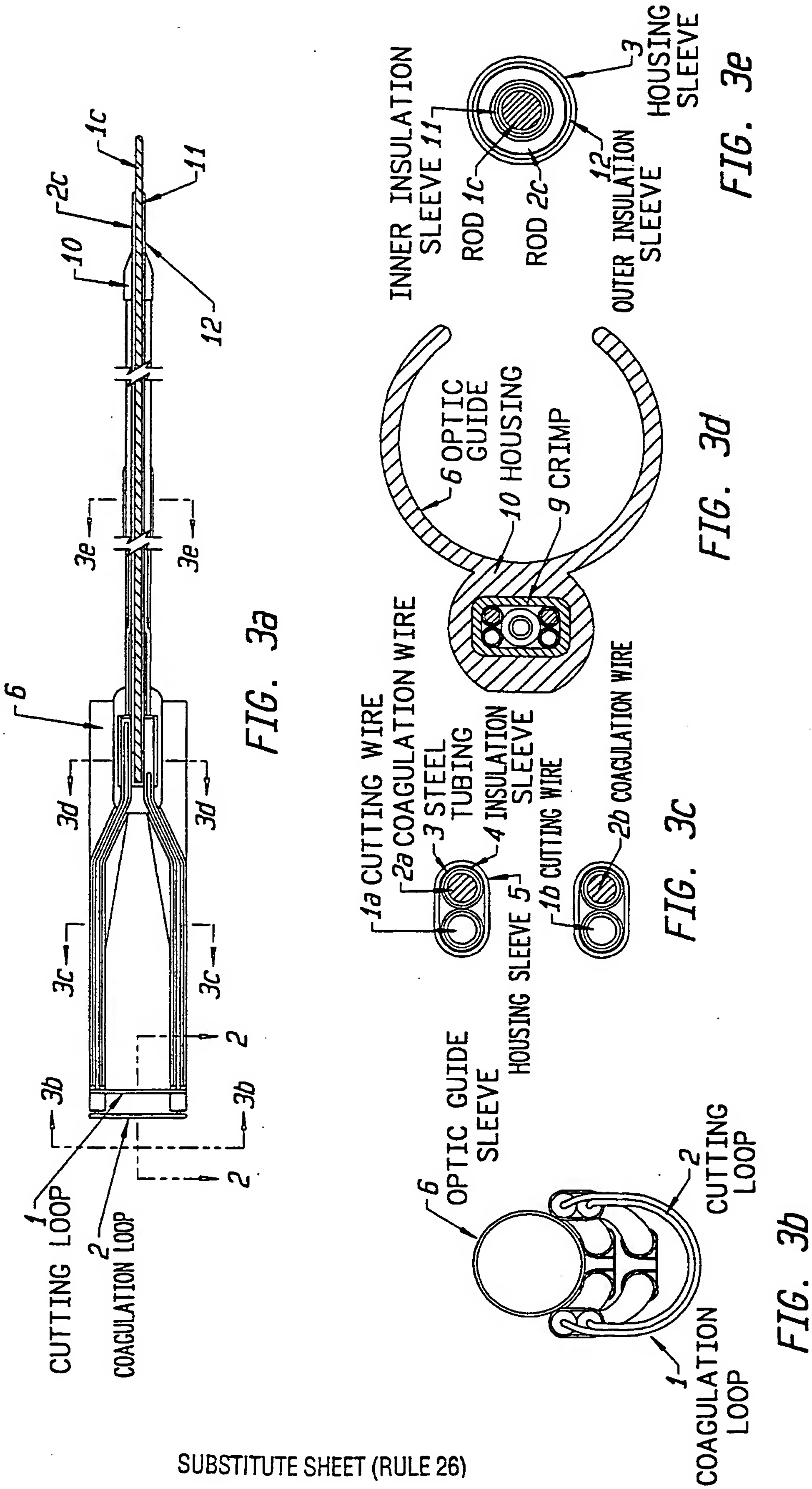


FIG. 3a

FIG. 3e

FIG. 3d

FIG. 3c

FIG. 3b

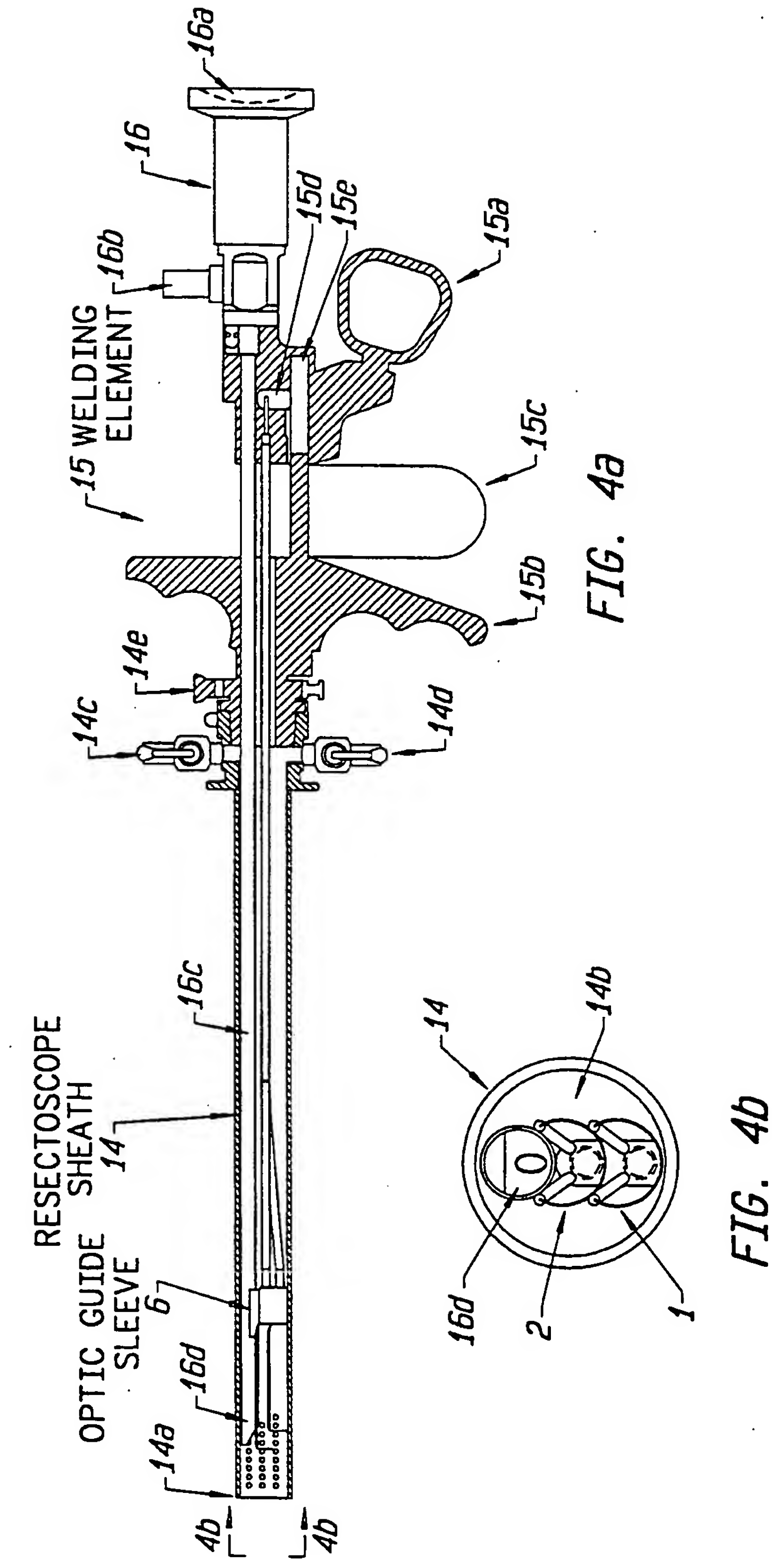
16a
16
16b
15d
15e
15a
15 WELDING ELEMENT
15c
15b
14e
14c
14d
16c
RESECTOSCOPE SHEATH
14
OPTIC GUIDE SLEEVE
6
16d
14a
4b
4b
14
14b
16d
2
1

FIG. 4a

FIG. 4b

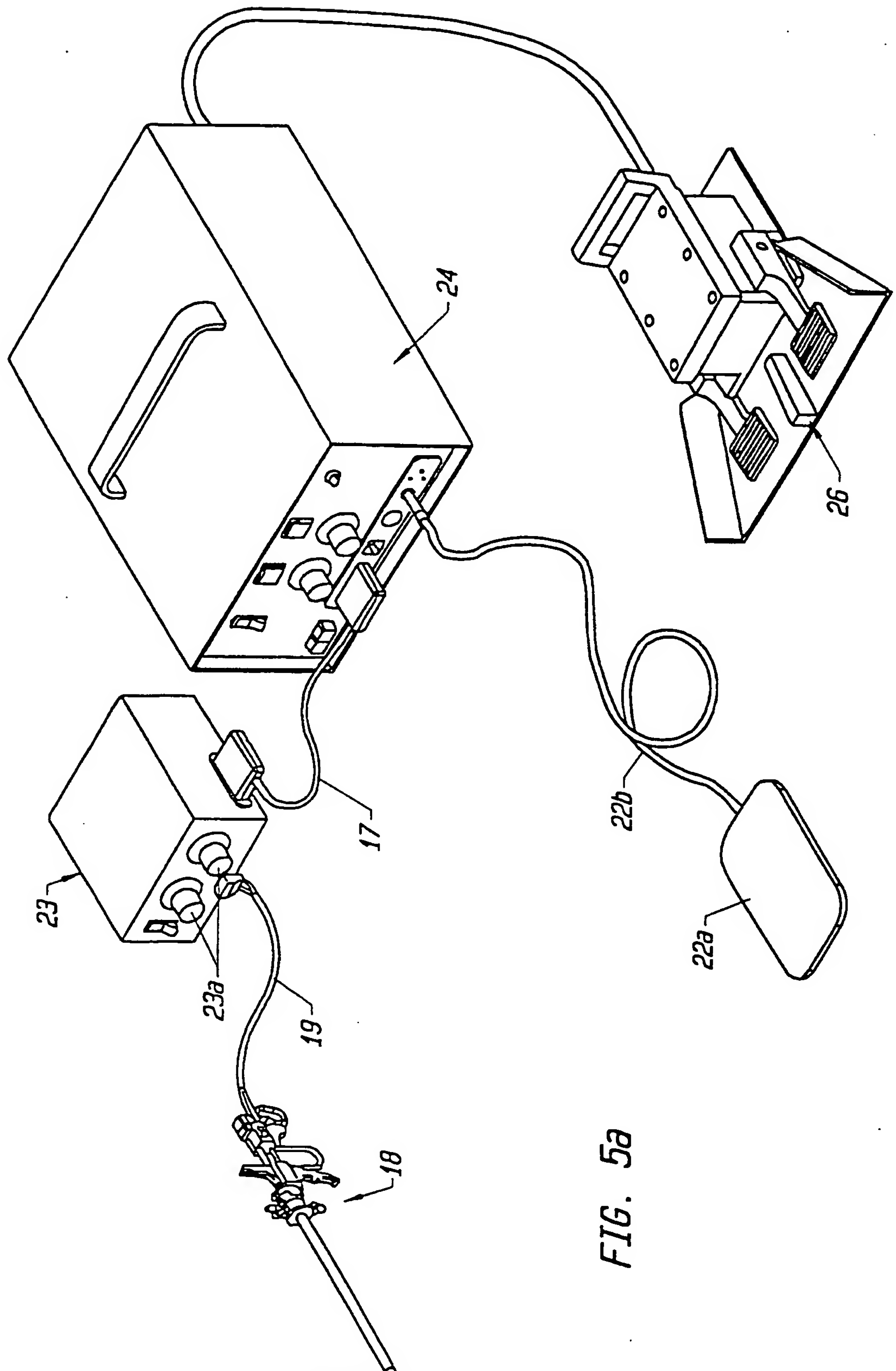


FIG. 5a

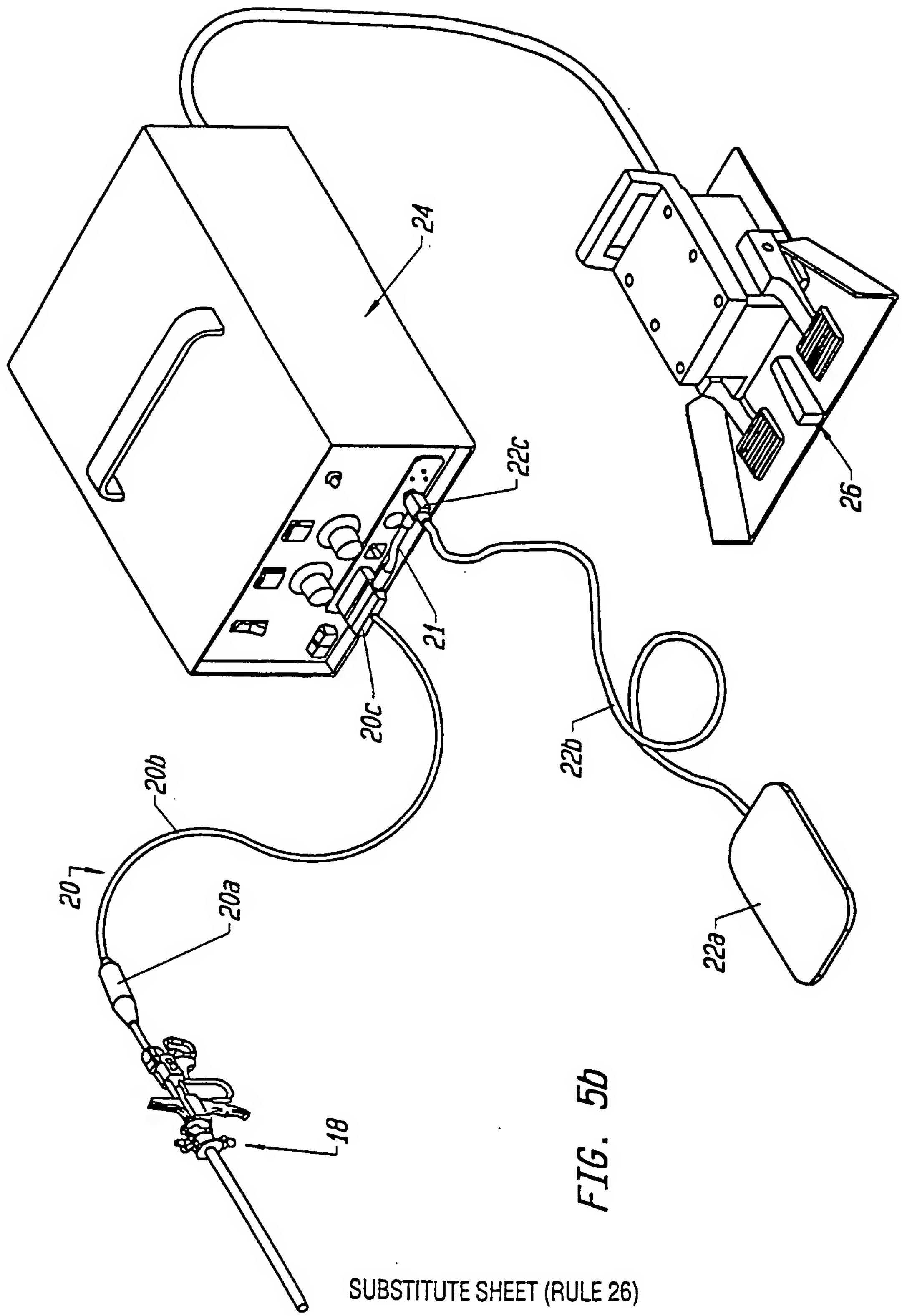


FIG. 5b

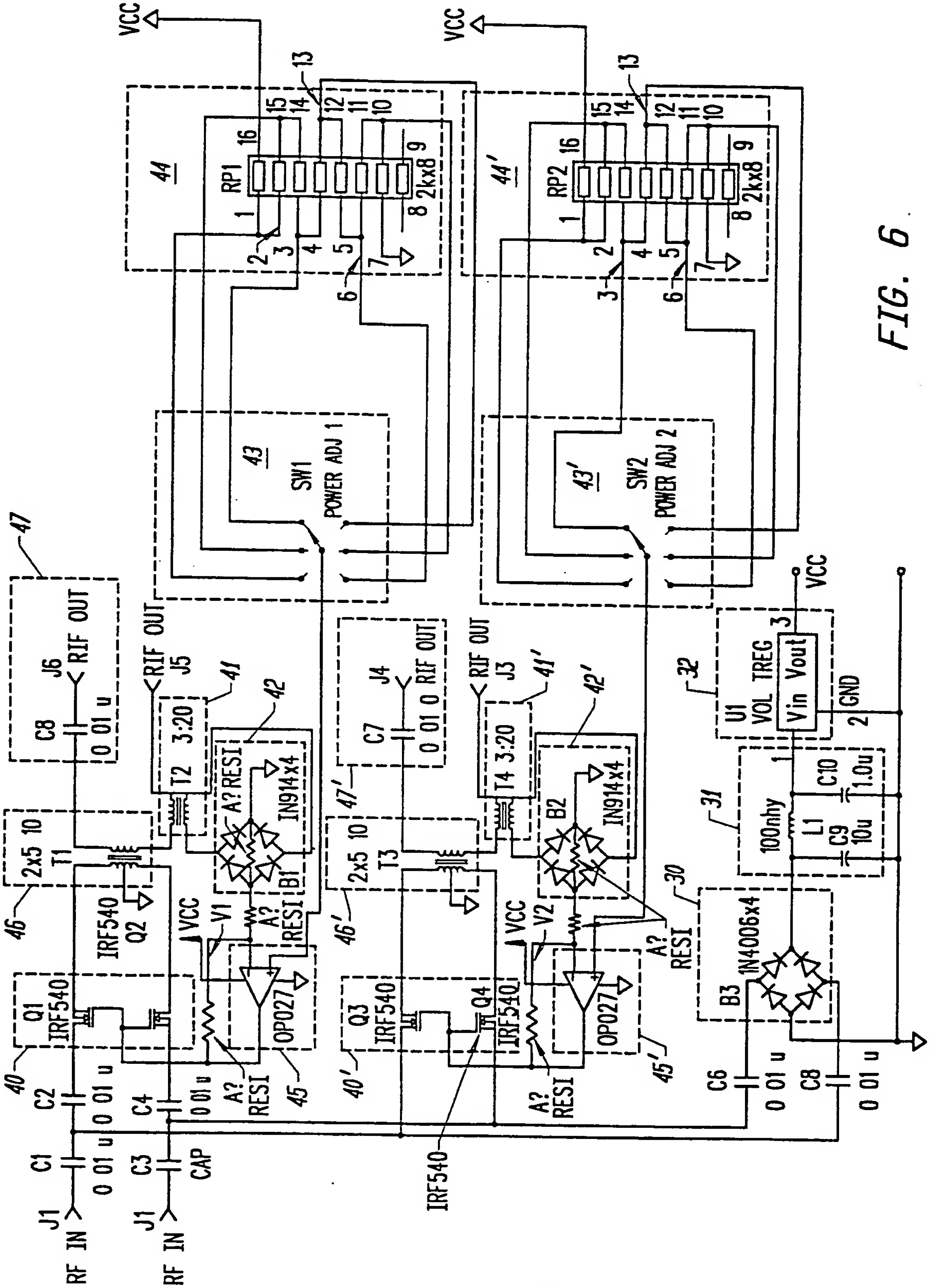
VCC
RP1
2kx8
44
13
VCC
RP2
2kx8
44'
43
SW1
POWER ADJ 1
43'
SW2
POWER ADJ 2
47
J6
RIF OUT
C8
0 01 u
RIF OUT
J5
T2 3:20
41
42
A? RESI
IN914x4
B1
J4
RIF OUT
C7
0 01 0
47'
RIF OUT
J3
41'
T4 3:20
42'
B2
IN914x4
32
U1
VOL TREG
Vin Vout
GND
VCC
31
100nhy
L1
C10
1.0u
C9
10u
30
B3
1N4006x4
46
2x5 10
T1
IRF540
Q2
VCC
V1
OP027
45
46'
2x5 10
T3
VCC
V2
A? RESI
OP027
45'
40
Q1
IRF540
40'
Q3
IRF540
Q4
IRF540
IRF540
C2
0 01 u
C4
0 01 u
C1
0 01 u
C3
CAP
C6
0 01 u
C8
0 01 u
J1
RF IN
J1
RF IN

FIG. 6

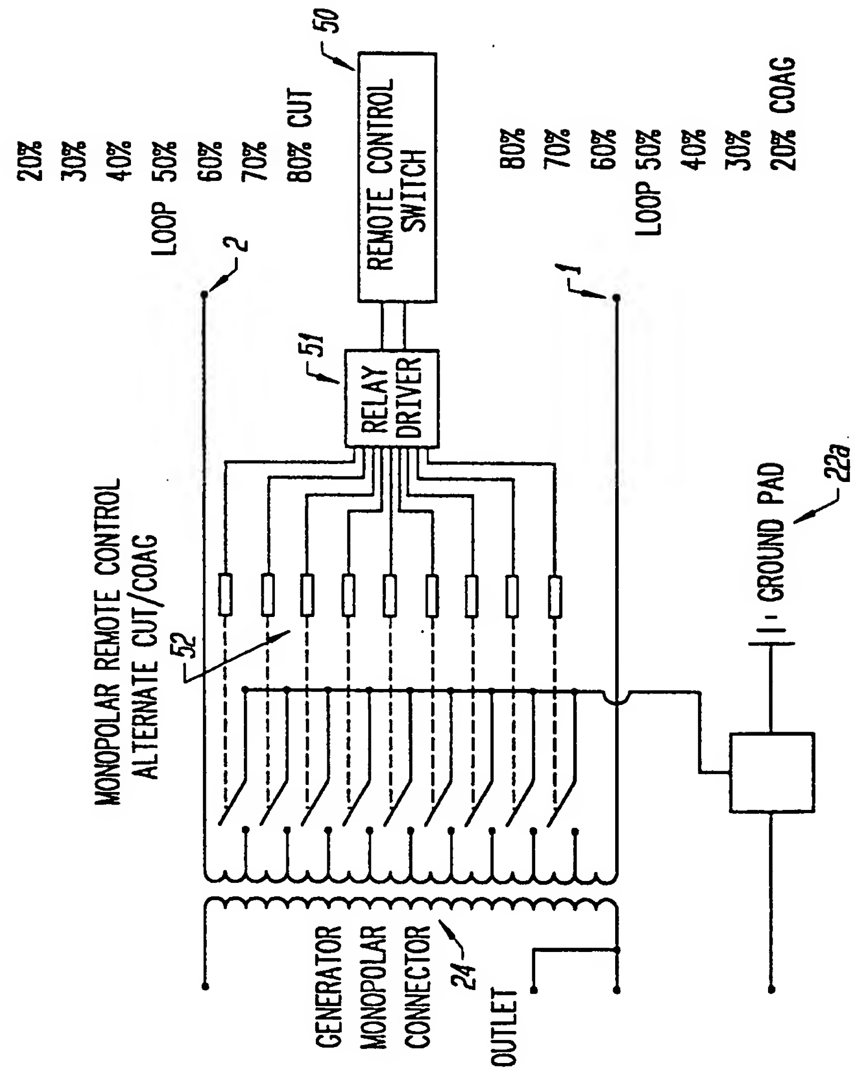
MONOPOLAR REMOTE CONTROL
ALTERNATE CUT/COAG
52
50
REMOTE CONTROL SWITCH
51
RELAY DRIVER
2
LOOP
20%
30%
40%
50%
60%
70%
80% CUT
1
80%
70%
60%
LOOP 50%
40%
30%
20% COAG
GROUND PAD
22a
GENERATOR
MONOPOLAR
CONNECTOR
24
OUTLET

FIG. 8

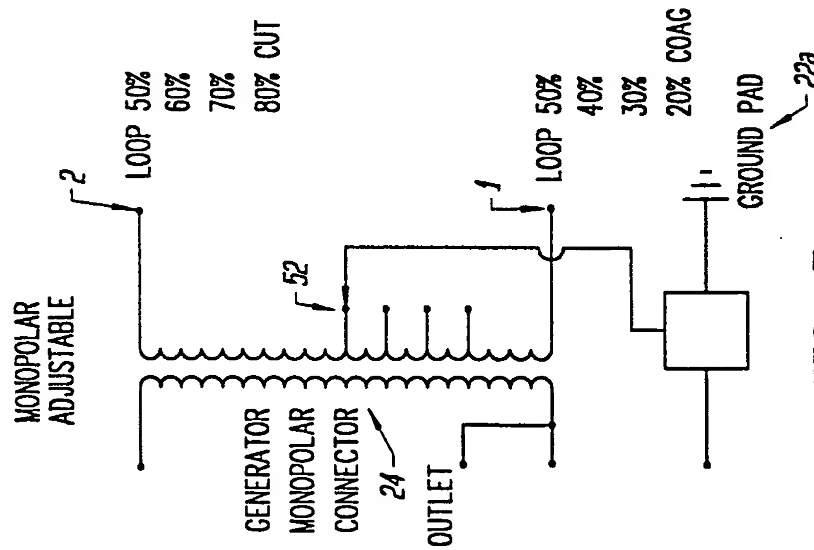
MONOPOLAR
ADJUSTABLE
2
LOOP 50%
60%
70%
80% CUT
52
1
LOOP 50%
40%
30%
20% COAG
GROUND PAD
22a
GENERATOR
MONOPOLAR
CONNECTOR
24
OUTLET

FIG. 7

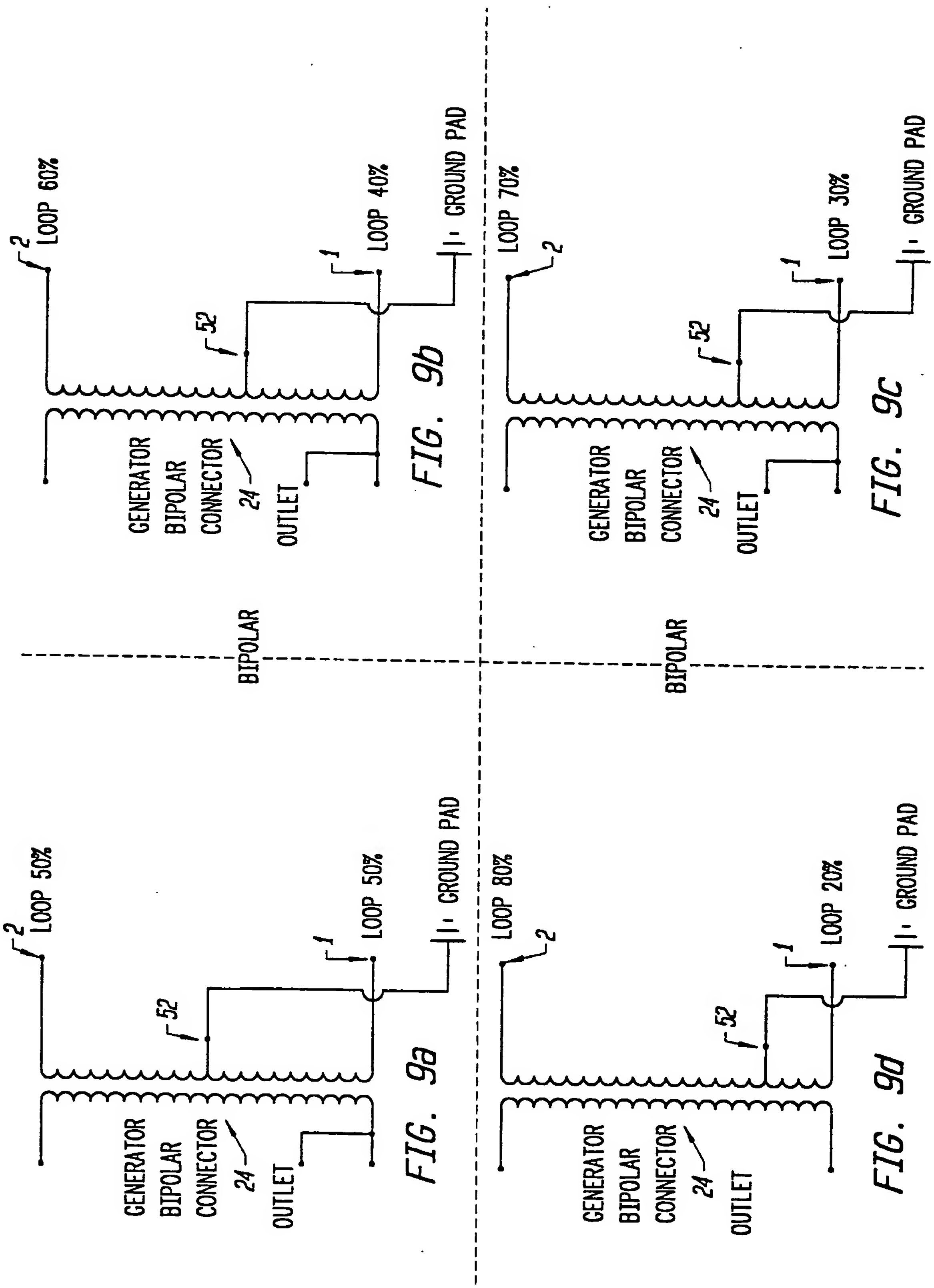


FIG. 9b

FIG. 9c

FIG. 9a

FIG. 9d

## INTERNATIONAL SEARCH REPORT

International application No.
PCT/US96/07009

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) :A61B 17/32
US CL :606/46
According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 606/37-42, 45-52

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

NONE

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

NONE

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| Y | US, A, 4,060,087 (HILTEBRANDT ET AL.) 29 November 1977, see whole document. | 1-39 |
| Y | US, A , 4,116,198 (ROOS) 26 September 1978, see whole document. | 1-39 |
| Y | US, A, 5,267,998 (HAGEN) 07 December 1993, see whole document. | 1-39 |
| Y | US, A, 5,190,541 (ABELLE ET AL.) 02 March 1993, see .whole document | 1-39 |
| Y | US, A, 4,969,885 (FARIN) 13 November 1990, see whole document. | 22, 23, 33, 34 |
| A | US, A, 3,850,162 (IGLESIAS) 26 November 1974, see whole document. | 1-39 |

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be part of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

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| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 21 JUNE 1996 | 19 JUL 1996 |

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| Facsimile No. (703) 305-3590 | Telephone No. (703) 308-4305 |